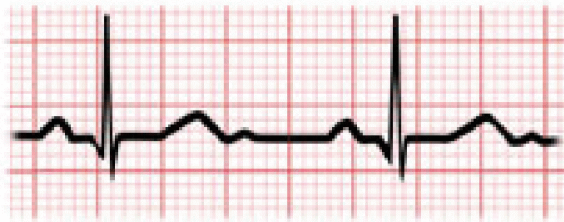
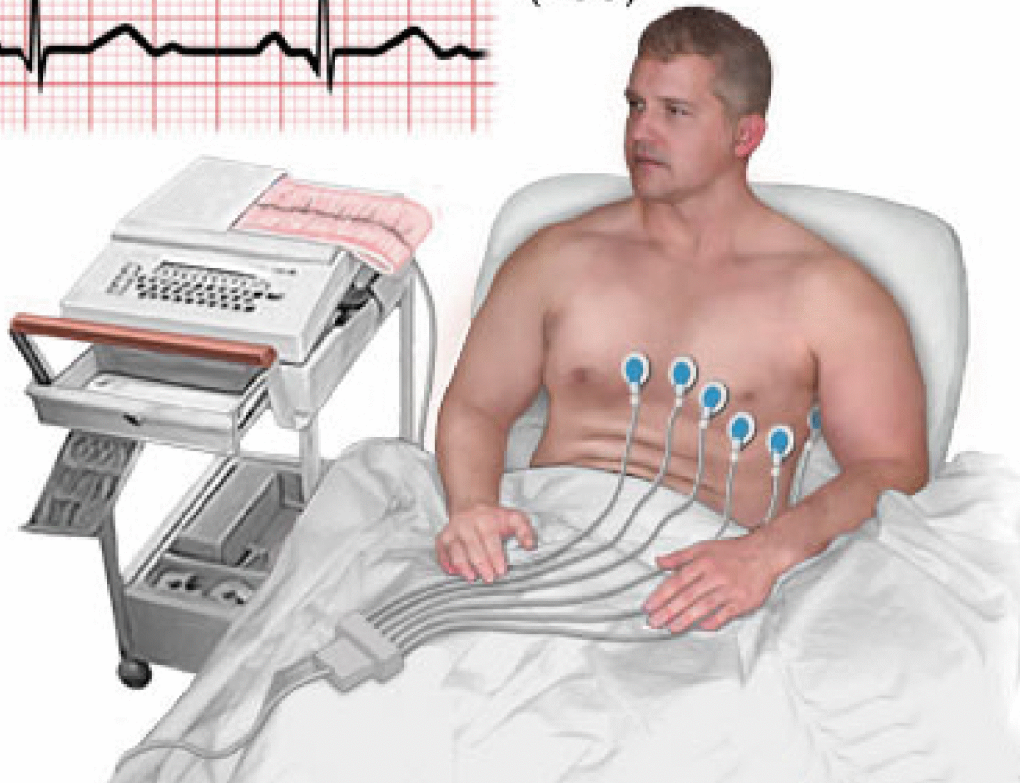


SUMMARY OF ECG



Electrocardiogram
(ECG)



NOTES OF MEDADTEAM

- Special thanks to Dr Ashraf Zaki



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1.5 L.E.



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Summary of ECG

1. Take a look at the leads & determine location of each wall:

I	High lateral	aVR	V1	Septal	V4	Strict anterior	
II	Inferior	aVL	High lateral	V2	Septal	V5	Low lateral
III	Inferior	aVF	Inferior	V3	Strict anterior	V6	Low lateral
II							

2. Make spot diagnosis

3. Use the scheme to:

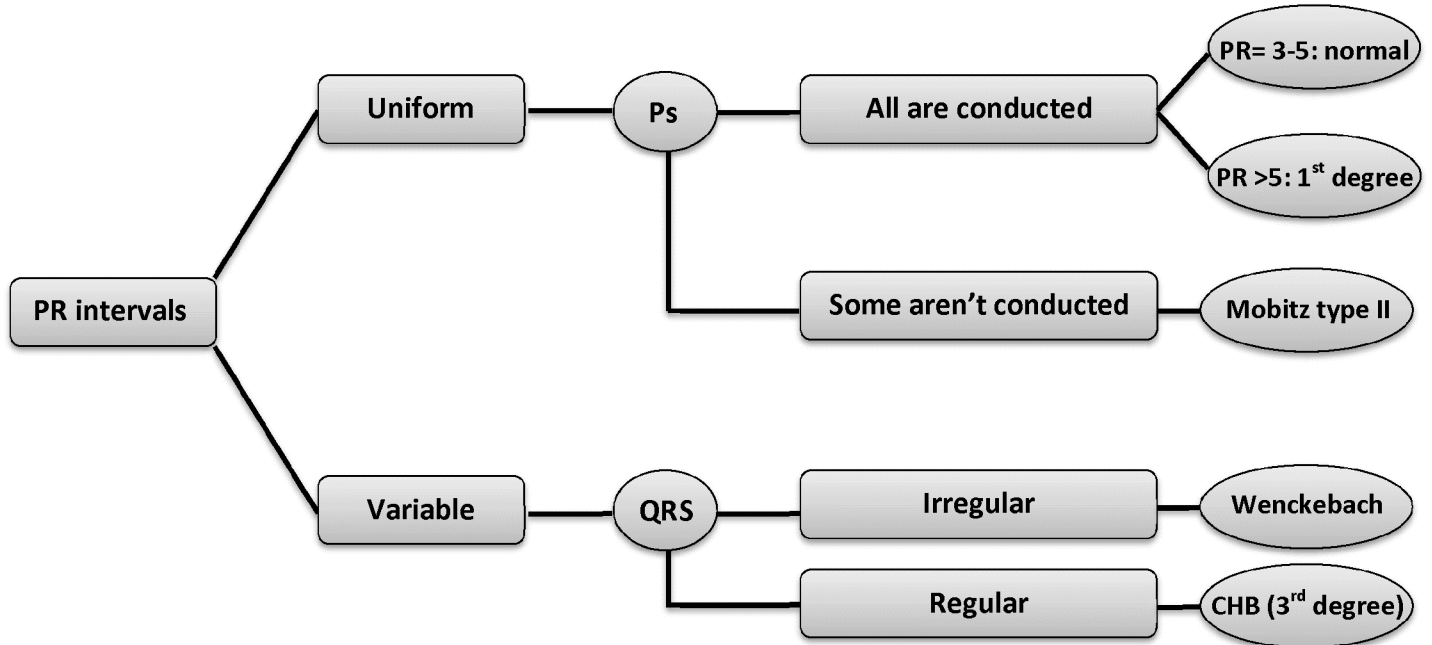
- Confirm diagnosis
- Correct diagnosis
- Complete diagnosis

Scheme for ECG

	Abnormality	Leads to look at	
		Limb leads	Chest leads
Step I	AV block Arrhythmia	Strip or II	
Step II	Atrial enlargement Bundle Branch Block Ventricular enlargement	II	V1 V1, V2, V5, V6
Step III	Axis Hemiblock	I/III or aVF Limb leads	
Step IV	Myocardial infarction Myocardial ischemia		I, L → high lateral wall II, III, F → inferior wall V1, V2 → septal wall V3, V4 → strict anterior wall V5, V6 → low lateral wall
Step V	Low voltage Digitalis Hyperkalemia Pre-excitation syndrome	I, II, III In all limb leads In all limb leads In all limb leads	

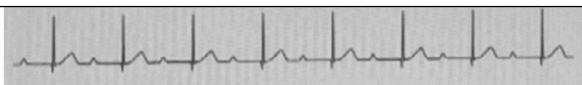
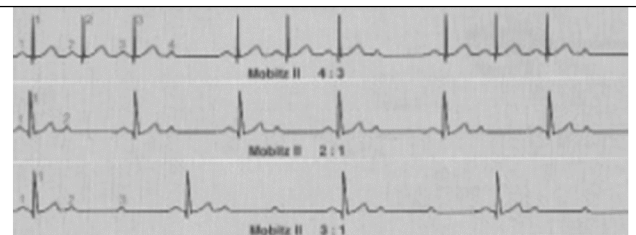
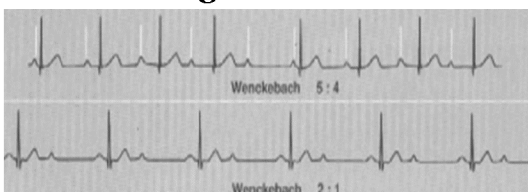
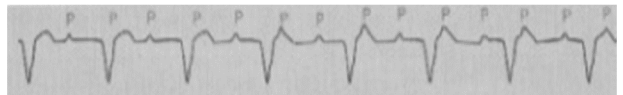
Normally:

- **P wave:** height ≤ 2.5 small squares – width < 3 small squares.
- **PR interval (P wave + PR segment):** width = 3-5 small squares.
- **QRS:** width < 2.5 small squares – height in LI + LII + LIII > 15 small squares.

Step 1:**I.1 Atrioventricular Block**

In second degree only (wenckebach & Mobitz type II):

- 1- Detect degree of block (P: QRS ratio -> 6:5 or 5:4 or 4:3 etc.....).
- 2- If block is 2:1, look at the width of the QRS:
 - If wide > 2.5 = Mobitz type II.
 - If narrow = wenckebach.
- 3- If shortest PR > 5 in wenckebach or PR > 5 in Mobitz type II = 1st degree Av block is associated.

First Degree AV Block**Mobitz Type II Second Degree AV Block****Mobitz Type I (Wenckebach) Second Degree AV Block****3rd Degree (Complete) Heart Block**

I.2 Arrhythmia:

1. Regularity:

- **Regular:**

Definition: uniform R-R intervals +/- 1mm

How to decide:

- By paper or divider
- If NO strip: compare R-R intervals in different leads
- If NO R-R in leads: do NOT comment on regularity

- **Irregular:**

Definition: variable R-R

Possibilities:

- Regular irregularity
- Irregular irregularity

- **Regular with occasional irregularity:**

Definition: ALL R-R are regular except one i.e. premature beat

2. Rate: (heart rate)

- **If regular R-R interval:**

Count number of squares (big or small) in R-R interval

$$\text{Rate} = \frac{300}{\text{R-R in big squares}} \quad \text{OR} \quad \frac{1500}{\text{R-R in small squares}}$$

- **If irregular R-R interval:**

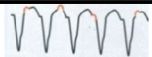
- If strip is
 - 10 big squares, so rate = number of QRS X 30
 - 20 big squares, so rate = number of QRS X 15
 - 30 big squares, so rate = number of QRS X 10
- Whether strip is present or not, choose THE MOST MIDDLE R-R INTERVAL (استوسطلك واحدة),
 So rate = $\frac{300}{\text{MOST MIDDLE R-R in big squares}}$

If NO strip & NO R-R in leads (one complex in each lead), do NOT comment

3. Pacemaker:

Scheme for pacemaker

Pacemaker	How to know		If the pacemaker is ..., so think about	
Sinus pacemaker	P wave: - Upright in II & - Inverted in aVR		Normal sinus rhythm	Differentiated by regularity & rate
			Sinus tachycardia	
			Sinus bradycardia	
			Sinus arrhythmia	
			Sinus pause	
Atrial pacemaker	NO sinus P wave P wave according to rhythm		Atrial ectopic focus	Differentiated by features of each pacemaker
			Atrial fibrillation	
			Atrial flutter	
			Multifocal atrial tachycardia	
			Wandering atrial tachycardia	

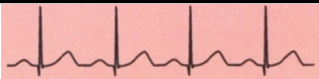
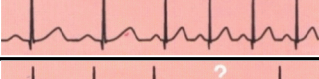
Junctional pacemaker	P wave: - Absent OR - Retrograde: Inverted in II, Upright in aVR Just before or just after QRS		Supraventricular tachycardia Escape Junctional rhythm Accelerated Junctional rhythm	Differentiated by rate (as ALL are regular)
Ventricular pacemaker	- Wide QRS Except supraheasal - T direction is opposite to QRS - +/- signs of AV dissociation		Ventricular tachycardia Escape idioventricular rhythm Accelerated idioventricular rhythm Ventricular fibrillation Ventricular flutter	Differentiated by rate (as ALL are regular except multifocal VT) Spot diagnosis
Artificial pacemaker	Spikes before QRS +/-P wave		Ventricular pacemaker Dual pacemaker	Differentiated by spikes

For determining type of arrhythmia

1. Determine the pacemaker
2. Decide which type of arrhythmia according to the rate and regularity

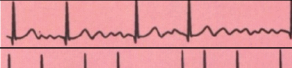
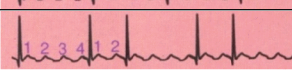
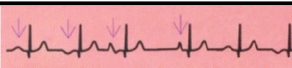
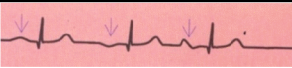
I. Sinus pacemaker:

Scheme for Sinus Pacemaker

1.pacemaker	2. decide arrhythmia			
	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Sinus rhythm P wave: • Upright in II • Inverted in aVR	Regular	60-100		Normal sinus rhythm
		100-180		Sinus tachycardia
		40-60		Sinus bradycardia
	Irregular	Any		Sinus arrhythmia
	Regular with OI (Dropped beat)			Sinus pause (Sick Sinus Syndrome)

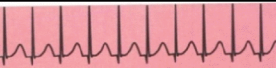
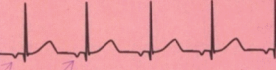
II. Atrial pacemaker:

Scheme for Atrial Pacemaker

1.pacemaker	2.deciding arrhythmia				Rhythm (Diagnosis)
	Pacemaker	Regularity	Rate	Lead II (Strip)	
Atrial pacemaker NO sinus P wave	Small P waves	Regular	>150		Supraventricular tachycardia
	Fibrillatory waves Absent P	Irregular	Any		Coarse Atrial fibrillation
	Flutter waves (Saw teeth)	Regular			Atrial flutter 4:1
		Irregular	Any		Atrial flutter with variable block
	≥ 3 different Ps	Irregular	Tachycardia		Multifocal atrial tachycardia (MAT)
			Bradycardia		Wandering atrial pacemaker

III. Junctional pacemaker:

Scheme for Junctional Pacemaker

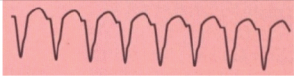
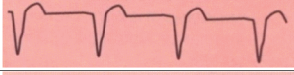
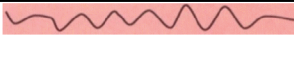
1.pacemaker	2.decide arrhythmia				Rhythm (Diagnosis)
	Regularity	Rate	Lead II (Strip)		
Junctional Pacemaker P absent or retrograde	Regular	>150 (>100)			Supraventricular tachycardia (PAVNRT)
		40-60			Escape Junctional rhythm
		60-100			Accelerated Junctional rhythm

ALL junctional rhythms are REGULAR, unlike fine AF which is IRREGULAR

Junctional rhythm (supraventricular tachycardia)	Atrial Fibrillation
Absent P wave	
Regular	Irregular

IV. Ventricular pacemaker:

Scheme for ventricular Pacemaker

1.pacemaker	2.decide arrhythmia				
r	Pacemaker	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Ventricular pacemaker Wide QRS T inversion AV dissociation			>150		Ventricular tachycardia
			<40		Escape idioventricular rhythm
			60-100		Accelerated idioventricular rhythm
			Don't exceed 30 seconds 3 or more beats		NON sustained ventricular tachycardia
		Irregular	Tachy		Multifocal ventricular tachycardia
					Torsades de pointes
					Bidirectional Ventricular tachycardia
NO QRS	Vent. fibrillatory waves	Irregular	Any		Ventricular fibrillation
	Ventricular flutter waves	Regular	300-400		Ventricular flutter

V. Ectopic beats

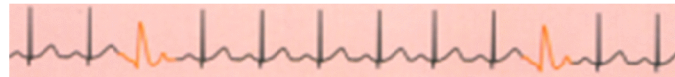
Scheme for Ectopic Beats

1. Decide whether ectopic beat is escape or premature		2. Decide whether ectopic beat (escape or premature) is atrial, junctional or ventricular		,So diagnosis	
If	,so	If			
Sinus rhythm →pause →ectopic beat →sinus rhythm	Escape beat	Small (atrial) P wave			Escape atrial beat
		Retrograde P wave			Escape Junctional beat
		Wide QRS T wave opposite QRS			Escape ventricular beat
	Premature beat	Small (atrial) P wave	Premature Pause		Premature atrial beat
		Retrograde P wave	Less than 2 Normal cycles		Premature Junctional beat
		Wide QRS T wave opposite QRS	Premature Pause equal 2 Normal cycles		Premature ventricular beat

Variable forms of premature beats:

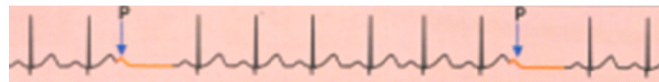
1) Premature atrial beat with aberrant conduction (Ashmann phenomenon):

Premature atrial beat occurs so early that it reach the ventricles during relative refractory period. So upstroke of ventricular depolarization is slow and intraventricular conduction of the impulse is slow with subsequent wide QRS.



2) Premature atrial beat with non-conducted P:

Premature atrial beat occurs more early than the mentioned above, so it reaches the ventricles during absolute refractory period → no QRS



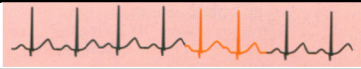
3) Monofocal premature beat:

Scheme for Monofocal Premature Beat

Monofocal premature beat	Premature beat occurs every constant number of sinus beats	1. Decide whether premature beats are atrial or ventricular	If	,So	If (Strip)	,So
			Small P wave	Atrial premature beats		Atrial bigeminy
			Wide QRS T wave opposite QRS	Ventricular premature beat		Atrial trigeminy
			Retrograde P wave	Junctional premature beats		Atrial quadrigeminy
		2. Decide whether premature beats are bigeminy, trigeminy or quadrigeminy				Ventricular bigeminy
						Ventricular trigeminy
						Ventricular quadrigeminy
						Junctional bigeminy
						Junctional trigeminy
						Junctional quadrigeminy

4) Couplet:

Scheme for Couplet

How to know	If	Lead II (Strip)	,So diagnosis
Couplet Sinus rhythm → premature beat → premature beat → sinus rhythm	Small P wave		Atrial couplet
	Retrograde P wave		Junctional couplet
	Wide QRS		Ventricular couplet
	T wave opposite QRS		

5) Interpolated premature beat:

Scheme for Interpolated Premature Beat

How to know	If	Lead II (Strip)	,So
Interpolated premature beat Sinus rhythm → premature beat → sinus beat (NO pause) Premature cycle + return cycle = ONE normal sinus cycle	Small P wave		Interpolated PAB
	Retrograde P wave		Interpolated PJB
	Wide QRS		Interpolated PVB
	T wave opposite QRS		

Step II

II.1. Atrial enlargement:

Look at

		V1	
II			

Scheme for atrial enlargement

	II	V1
Normal	Positive, W < 3mm, H ≤ 2.5mm	Biphasic
Left	Broad, W ≥ 3mm P mitral +/- notched	-ve > 1x1
Right	Tall and peaked, H > 2.5 P pulmonale	+ve > 1.5 in H
Biatrial	P mitral & P pulmonale	+ve P is tall > 1.5 & -ve P is board > 1

For diagnosis of atrial enlargement, a change in ONE lead is ENOUGH

II.2. Bundle Branch Block:

Look at

		V1	
		V2	V5
			V6

Spot diagnosis: WIDE QRS at V1, V2, V5, V6

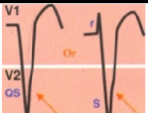
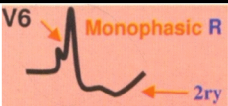
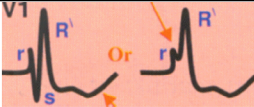
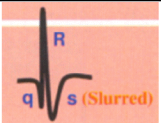
i. Is QRS complex (Normal < 2.5mm) wide?

If >3mm → complete BBB

If 2.5-3mm → incomplete BBB

ii. In both cases, determine whether right or left:

Scheme for Bundle Branch Block

	V1, V2		V5, V6 & I	
LBBB	QS or rS		+	Monophasic R with secondary inversion of T wave
				
RBBB	rSR' or monophasic R with secondary inversion of T wave		+	qRs (with slurred s)
				
IVCD	LBBB		+	RBBB
	RBBB		+	LBBB

➤ If RBBB is diagnosed, NEVER diagnose:

- Ventricular enlargement
- Myocardial ischemia

➤ If LBBB is diagnosed, NEVER diagnose : above conditions+

- Myocardial infarction (diagnosed if new onset LBBB with typical ischemic chest pain or elevated cardiac enzymes)
- Hemiblock.

➤ **Pacemaker: in LBBB ONLY (or IVCD)**

If LBBB is associated with spikes, this indicates pacemaker:

- If one spike (before QRS) → ventricular pacemaker
- If TWO spikes (one before P, and other before QRS) → Dual pacemaker
- If spike is NOT followed by QRS → malfunctioning pacemaker

II.3. Ventricular enlargement:

Look at

		V1	
		V2	V5
			V6

Scheme for Ventricular Enlargement

V1, V2

V5, V6

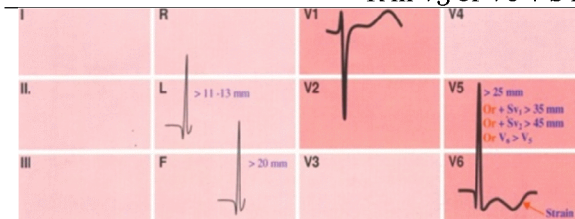
LVE 6 features (ANY one is diagnostic, but ALL must be excluded negative to exclude LVE)

R in V5 or V6 > **25 mm** (5 big squares)

R in V5 or V6 + S in V1 > **35 mm** (7 big squares)

R in V5 or V6 + S in V2 > **45 mm** (9 big squares)

R in V6 > R in V5



R in aVL > **13 mm**

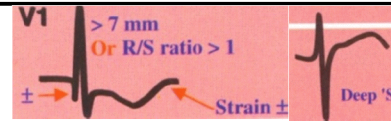
R in aVF > **20 mm**

+/- ST depression(strain sign) = hypertrophy > dilatation

RVE Tall R in V1 > 7 mm or R in V1 ≥ S in V1

Deep S in V6

+/- ST depression(strain sign) = hypertrophy > dilatation



BVE Signs of LVE + tall R in V1 or Signs of LVE + Rt. Axis deviation.

Step III

III.1. Axis:

Look at:

I			
III	aVF		

Scheme for Axis

	Normal axis deviation	Left axis deviation	Right axis deviation	Extreme axis deviation
I				
III or aVF				

IF THE AXIS IS DEVIATED, SEARCH FOR HEMIBLOCK

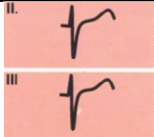
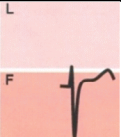
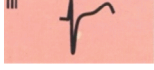
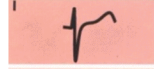
III.2. Hemiblock:

Look at: inferior and high lateral leads

I			
II	aVL		
III	aVF		

Search for hemiblock if axis is deviated

Scheme for Hemiblock

LAHB	Left axis deviation		Deep S in inferior leads (II, III, aVF) in aVF especially (as normal in III)		
Left anterior HB			(NO need to exclude other causes of left axis deviation)		
		III			
LPHB	Right axis deviation		Deep S in high lateral leads (I, aVL)		
Left posterior HB			(provided that it is NOT explained by RVE)		
		F			

NB | If hemiblock + RBBB → **Bifascicular block hemiblock**
 If hemiblock + RBBB + 1st HB → **Trifascicular block hemiblock**

Step IV

IV.1.2. Myocardial infarction and ischemia:

Search for ALL changes in EACH lead

Changes:

- Is there Pathological Q (or poor progression of R)?
- Is there ST elevation (or ST depression)?
- Is there T inversion (or hyperacute, biphasic or flat T wave)?

CHANGES must be in 2 SUCCESSIVE LEADS of the SAME WALL

➤ Pathological Q:

- Wide ($\geq 1\text{mm}$) & deep ($\geq 2\text{mm}$ or $\geq 1/4$ the following R)
- In 2 successive lead of the same wall

➤ Poor progression of R: in anterolateral infarction

- R is NOT $>S$ in V₄

➤ ST elevation:

- First mm after J point is elevated than isoelectric line
- Isoelectric lines (baseline) are P-R segment or T-P segment
- Considered elevated if:
 - $\geq 1\text{mm}$ in limb leads
 - $\geq 2\text{mm}$ in chest leads

- Determine straightened or coved according to T wave & J point elevation
- **These changes MUST be IN 2 SUCCESSIVE LEADS of the SAME WALL**

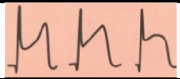
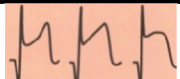
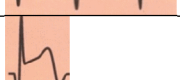
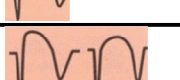
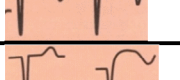
If:

- ST elevation (+/- ST depression in other walls) → **ST elevation Myocardial Infarction (+/- reciprocal ST depression)**
- ST depression ONLY → **Myocardial ischemia**

If ST Elevation Myocardial Infarction, determine age & site:

1. Age:

Scheme for age of STEMI

Spot diagnosis	Age of STEMI	How to know			
		ST segment	Q wave	T wave	
	Hyperacute	ST elevation	NO pathological Q	+/- Hyperacute T wave	
	Acute	ST elevation	Pathological Q Or poor R progression	+/- Hyperacute T wave	
				Biphasic (intermediate phase)	
	Evolving	ST elevation	Pathological Q Or poor R progression	Inverted T	
	Old	NO ST elevation	Pathological Q Or poor R progression	Normal T	

2. Site:

I	High lateral	aVR	V1	Septal	V4	Strict anterior
II	Inferior	aVL	V2	Septal	V5	Low lateral
III	Inferior	aVF	V3	Strict anterior	V6	Low lateral

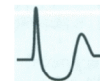
Anteroseptal = V1-V3 + \- V4

Anterolateral = V3-V6 + I & aVL

Extensive anterior = V3-V6 + I & aVL

Posterior wall MI:

- Tall R in V1, V2, V3 – ST depression – upright T
- Associated with inferior myocardial infarction (to differentiate it from RVE)



RVE

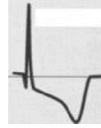
Posterior MI

Tall R in V1, V2, V3

Associated with Inferior MI

ST depression in some leads:

- If associated with ST elevation in other leads → **RECIPROCAL ST DEPRESSION associated with MI**



- If alone → **MYOCARDIAL ISCHEMIA:**

ST depression: start after J point, is $\geq 1\text{mm}$ in limb leads or $\geq 2\text{mm}$ in chest leads & last for $>2\text{mm}$.

T wave: flat or symmetrically inverted or symmetrically upright.

Step V**V.1. Low voltage:**

Look at

I			
II			
III			

How to know

- QRS in I + II + III $< 15\text{mm}$

NB

Electrical alternans in pericardial effusion:

- LOW voltage

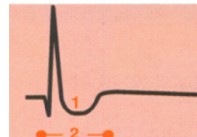
+

**V.2. Digitalis effect: in ALL LEADS**

Digitalis effect:

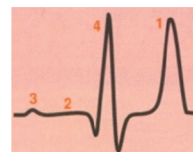
- Short QT i.e. $QT < \frac{1}{2} RR$
- Sagging ST depression:
 - J point is isoelectric (unlike ischemia)
 - ST depression + T inversion
 - Fused ST & T

NB | Normal $QT = \frac{1}{2} RR$

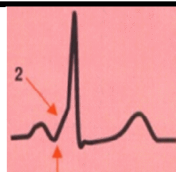
**V.3. Hyperkalemia: in ALL LEADS**

How to know:

Hyperacute T wave alone (tall, narrow & peaked)

**V.4. Preexcitation syndrome: in ALL LEADS****Scheme for prexcitation syndromes****WPW-Wolf Parkinson White**

- Short PR interval
- Delta wave
- Wide QRS

**LGL-Lawn Ganong Levine**

- Short PR interval

